interobserver reproducibilities. High associations between MRI and radiographic osteoarthritis scores were noted for both KL ($p = 0.0006$) and OARSI scores ($p<0.001$). The newly developed score was also highly correlated with clinical parameters, including total score and each subcategory of the HOOS questionnaire ($p < 0.0013$).

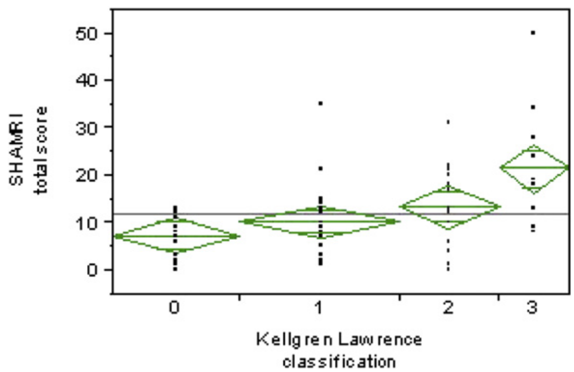

Figure 1. SHAMRI total score and Kellgren Lawrence grading.

Conclusions: The novel MRI evaluation system of hip osteoarthritis designed for practical application and easy surgical correlation showed high intra- and inter-observer reproducibility and high correlation with radiographic osteoarthritis and clinical parameters.

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BONE MINERAL DENSITY CHANGES FOLLOWING ANTERIOR CRUCIATE LIGAMENT RUPTURE

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Purpose: An anterior cruciate ligament (ACL) rupture is a common sports related injury in young people. A long-term consequence of an ACL rupture is the development of osteoarthritis (OA). The pathophysiology of an ACL rupture leading to evident knee OA still remains largely unknown. Previous studies showed a relation between high subchondral bone mineral density (BMD) in the tibia and risk of developing OA in the knee. In contrast, the BMD in the knee after an ACL rupture seems to be lower compared to the contralateral knee. The aim of this study is to determine differences in BMD between affected and contralateral knees in patients with an ACL rupture and if BMD changes occur during 2 years follow-up.

Methods: The KNALL (KNee osteoArthritis anterior cruciate Ligament Lesion) study is a prospective follow-up study in which 154 patients were included with an ACL rupture. The patients were included after the initial trauma up to 6 months and evaluated each year up to 2 years. Patients were treated operatively or non-operatively. Inclusion criteria were age between 18 and 45 years and an ACL rupture diagnosed by physical examination and MRI. Patients with previous ACL injury or meniscus or cartilage damage (diagnosed by an orthopaedic surgeon or sports physician); those with previous surgery of the involved knee; those with disabling co-morbidity; and those with already osteoarthritic changes on X-ray (Kellgren & Lawrence > 0) were excluded. Patients were recruited at three outpatient clinics of the department of orthopaedics in the Netherlands. At baseline, one year and two years follow-up BMD was measured for both knees using a DEXA scanner (anteroposterior views). Six regions of interest (ROI) were determined as follow: we outlined the contours of the femur and tibia by placing anatomical landmark points using the ASM toolkit software package. Using the anatomical landmark points we automatically extracted 6 ROIs: ROI 1 (medial), 2 (central), 3 (lateral) in the tibia and 4 (medial), 5 (central) and 6 (lateral) in the femur. The regions in the tibia were positioned just below the subchondral bone. The regions in the femur were positioned such that the medial and lateral ROI were placed inside the respective condyles. At the same visits questionnaires were filled in, physical examination, X-rays and MRI's were performed.

Results: For the DEXA scan analysis we included 141 patients with the following characteristics: 66 % was male, median age at baseline was 25.5 years (IQR 21.5 - 32.6), median body mass index was 23.7 kg/m2 (IQR 21.9 - 26.2), median preinjury Tegner activity score was 9 (IQR 7 - 9), median time injury to inclusion was 81 days (IQR 53 -122), 63 % was treated operatively and median time injury to surgery was 172 days (IQR 100.5 - 253).

Table 1
Overview of BMD values in all ROIs in affected and contralateral knee

	Mean BMD (g/cm^2) affected knee	Mean BMD (g/cm^2) contralateral knee
Baseline		
ROI 1/27 3	0.951/ 0.955/0.955	0.991/ 1.004/1.003
ROI 4/ 5/ 6	1.076/ 1.335/ 1.225	1.100/ 1.364/1.276
1 year follow-up		
ROI 1/2/3	0.921/0.899/0.904	0.982/0.988/0.987
ROI 4/ 5/ 6	1.028/1.300/ 1.192	1.108/ 1.390/ 1.281
2 years follow-up		
ROI 1/2/3	0.955/0.920/0.945	0.997/0.981/0.987
ROI 4/ 5/ 6	1.035/1.342/ 1.236	1.107/ 1.410/ 1.298

An overview of the results is given in table 1. At baseline, one year and two years follow-up the mean BMD values in all ROIs were significantly lower in the affected knee compared to the contralateral knee. The mean BMD values in all ROIs in the affected knee were significantly decreased after one year follow-up compared to baseline. Between follow-up 1 year and 2 years the mean BMD increased significantly in all ROIs excluding the medial femurcondyle in the affected knee. In the operatively treated patient group the BMD decrease was significantly larger than in the non-operatively treated group.

Conclusions: During two years after ACL rupture the BMD in the affected knee is lower compared to the contralateral knee. Patients treated operatively had a larger decrease in BMD than patients treated non-operatively.

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MINERALIZATION OF MENISCAL ENTHESIS IN OSTEOARTHRITIC KNEES

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Purpose: Meniscal entheses consist of a graded tissue interface which transitions from the ligament like structure of the main body meniscus to uncalcified fibrocartilage to calcified fibrocartilage to subchondral bone. Appropriate function of the menisci is dependent on entheses integrity. Because mineralization gradients dictate mechanics of other soft-tissue-to-bone insertion sites in the body, it is hypothesized that the graded mineralization of meniscal entheses may similarly influence meniscal mechanics. Meniscal extrusion occurs when the meniscal attachments become weakened and the meniscus extends beyond the tibial margin. This extrusion is a precursor of osteoarthritis (OA). The aim of this study was to assess changes in mineralization of meniscal enthesis that may occur in end-stage OA.

Methods: Healthy tissue (n=3) was obtained from human cadaveric donors and end-stage OA tissue (n=3) was obtained from patients undergoing total knee arthroplasty. Meniscal attachments (medial anterior/posterior and lateral anterior/posterior) were excised from the tibial plateau and scanned via micro-computed tomography (Sanco μCT 80). Mineral density measurements were taken across each enthesis, from the tidemark to the beginning of trabecular bone, using Image Processing Language (Scanco Medical AG). A custom Matlab script was used to identify the area of mineralization and average mineralization values. The thickness of the mineralized zone was calculated by assessing the number of data points over which the initial mineralization peak occurred. Student's t-tests were performed to compare thickness and average mineral density of healthy and OA entheses. Additionally, a sigmoidal Gompertz function was fit to the data and used to assess the points of initiation of mineralization, the mineralization growth rates, and the peak mineralization values.

Results: Mineralized zones were significantly thicker in OA mensical entheses compared to healthy samples ($p < 0.05$) (Figure 1). Average bone mineral density was significantly greater for healthy meniscal entheses ($p < 0.05$) (Figure 2). The fit of the Gompertz function (Figure 3) indicated that the rate of mineralization increase across the tidemark was greater for OA samples.

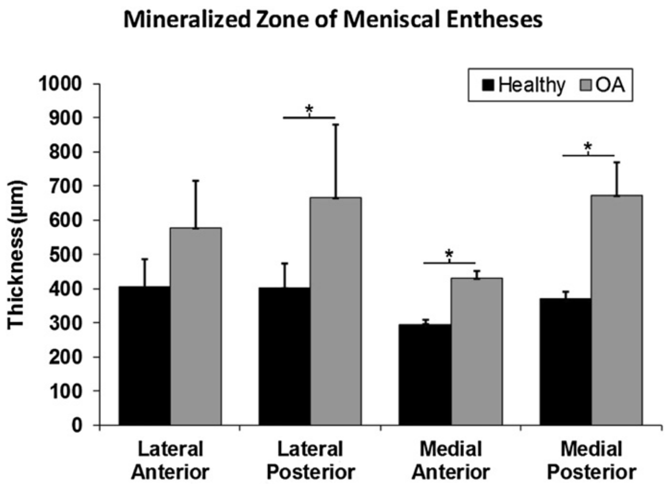

Figure 1. Mineralized zone of healthy and osteoarthritic meniscal entheses (* $p < 0.05$).

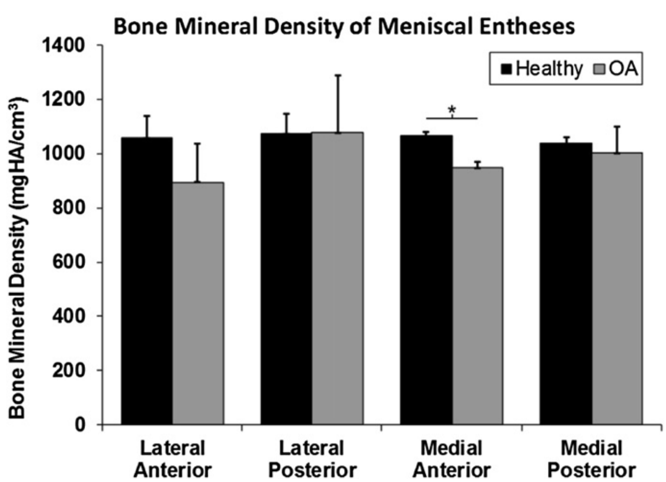

Figure 2. Average bone mineral density of healthy and osteoarthritic meniscal entheses (* $p < 0.05$).

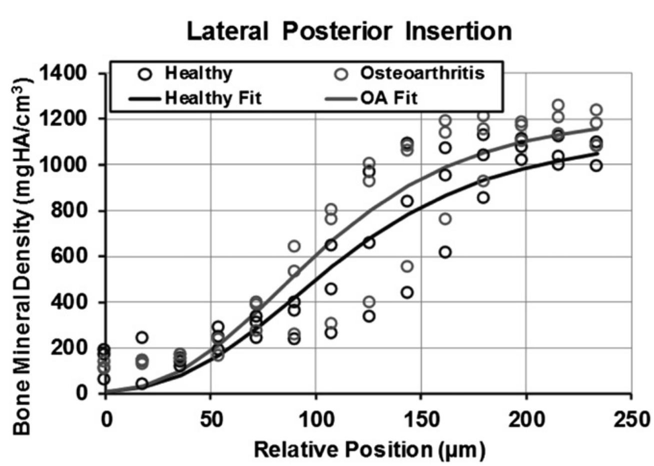

Figure 3. Fit of sigmoidal Gompertz function to mineralization of a meniscal enthesis.

Conclusions: The μCT analysis performed suggests that changes in calcified fibrocartilage and subchondral bone of meniscal attachments occur as a result of OA. Changes in subchondral bone due to OA pathogenesis alter cartilage mechanics and may similarly affect the mechanics of meniscal entheses. Although osteoarthritic meniscal entheses showed an increase in thickness of the mineralized zone, a decrease in average bone mineral density was shown, suggesting excessive bone remodeling and incomplete mineralization. Altered mineralization may cause mechanical weakening of the entheses and encourage the progression of meniscal extrusion. Future work regarding mineralization of meniscal entheses includes elucidating the effects of mineralization changes on enthesis mechanics and evaluating the progression of OA using various time points of disease.

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THE LONGITUDINAL RELATIONSHIP BETWEEN CHANGES IN BODY WEIGHT AND CHANGES IN KNEE CARTILAGE AND PAIN AMONG COMMUNITY-BASED ADULTS WITH AND WITHOUT MENISCAL TEARS

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Purpose: Meniscal tears are commonly found on magnetic resonance imaging (MRI) and increase the risk for incident radiographic knee osteoarthritis (OA). While meniscectomy is recommended when there is severe knee pain or associated knee locking, it is unclear how to best treat meniscal tears in the absence of these symptoms. The aim of this longitudinal study was to examine the effect of weight change on knee cartilage and pain in a cohort of community-based adults with and without meniscal tears detected by MRI.
Methods: 250 adults (78% completing follow-up) with no history of knee OA or knee injury were recruited from the general community and weight loss clinics. MRI of the knee, Western Ontario and McMaster University Osteoarthritis Index (WOMAC), weight and height were measured at baseline and again at follow-up approximately 2 years later.
Results: Medial meniscal tears were present in 36 (18%) of the cohort. In those with medial meniscal tears, after adjustment for age, gender, body mass index, the presence of medial tibiofemoral osteophytes and time between MRI scans, percentage weight change was significantly associated with percentage change in medial tibial cartilage volume [0.2% (95% CI 0.08% - 0.30%), $p = 0.002$] and knee pain [11.6% (95% CI 2.1% - 21.1%), $p = 0.02$]. In those with no medial meniscal tear, neither change in knee cartilage volume [0.02% (95% CI -0.005% - 0.10%), $p = 0.53$] or pain [1.9% (95% CI -2.2% - 6.1%), $p = 0.36$] was significantly associated with change in weight.
Conclusion: This study demonstrated that among adults with medial meniscal tears, weight gain is associated with increased cartilage loss and pain, while weight loss is associated with the converse. This suggests attention to weight is particularly important in the management of people with medial meniscal tears.

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MRI-BASED ASSESSMENT OF LOWER EXTREMITY MUSCLE VOLUMES IN PATIENTS WITH KNEE OSTEOARTHRITIS

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Purpose: To describe lower extremity muscle volumes in patients with knee joint osteoarthritis.
Methods: Seven patients with radiographic evidence of knee joint osteoarthritis (6M, 1F, 47±9yrs, 183±5cm, 99±21kg) were scanned on a 3T Siemens Trio MRI scanner. Axial images were acquired for the lower extremity ranging from the ankle to the thoracic vertebre. Thirty-four lower extremity muscles were manually segmented using a semi-automated program written in Matlab. Individual muscle volumes were normalized to patient height and mass. Normalized volumes for each muscle were converted to z-scores relative to a database of volumes collected from normal healthy volunteers. The z-scores were averaged across the patients and means, 95% confidence intervals calculated.
Results: On average, the vastus lateralis (z=-4.1, [%CI=4.5,3.8]) rectus femoris (z=-2.2, [-2.6, -1.9]) pectineus (z=-2.5 [-3.0, -1.9]) and obterator externus (z=-2.1 [-2.6, -1.6]) volumes were all more than 2 standard deviations below the corresponding muscle volume means of the healthy group. The vastus intermedius (z=1.4, [0.5, 2.4]) and obterator internus (z=2.0, [0.7, 3.2]) were the only muscles that were on average larger than healthy control with confidence intervals not crossing zero (Fig 1)
Conclusions: Patterns of lower extremity muscle deficits include the quadriceps and deep hip muscles that adduct the thigh however,